The Deep Underground Scientific and Engineering Laboratory (DUSEL)

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The scientific case for a deep underground laboratory has been convincingly and enthusiastically made over the past ~ five years. The spectrum of science and engineering topics that will be pursued at a deep underground laboratory is extremely broad and encompasses topics that are central to the future of nuclear physics, high energy physics, geophysics and earth sciences, and the growing field of particle astrophysics. A deep underground laboratory will play key roles in homeland security and national defense in providing essential and state-of-the-art facilities. Importantly, a deep underground laboratory will provide a domestic campus for the next generation of researchers and students. This unique facility will be *world class* and will draw participants from around the world, providing US researchers and students the opportunity to lead in the development of science and technologies. No other laboratory or proposed laboratory in the world offers the environment to pursue the scope or range of topics that will be approached at Homestake. Homestake will be the world focus for underground research.

Underground physics has its roots in the United States and in Homestake. Arguably, the first notable physics experiment of scale in underground physics was the Homestake Solar Neutrino experiment. Professor Ray Davis was awarded the Nobel Prize in Physics in 2002 for his vision in establishing this underground experiment to investigate the solar fusion processes. The Homestake experiment discovered much more than originally hoped for. The Homestake experiment provided the first case for new physics and physics beyond the Standard Model in nearly thirty years. The case for the neutrino revolution was spectacularly made with the Sudbury Neutrino Observatory (SNO), KamLAND and the Super-Kamiokande experiments. The SNO experiment resolved the Solar Neutrino Problem convincingly demonstrating that 2/3 of the neutrinos emitted from the sun *oscillate* into different neutrino families. Together SNO and the other solar neutrino experiments (SAGE, GALLEX, GNO, Homestake) and KamLAND have restricted possible mechanisms to explain the oscillations to a new and generally unexpected one. In addition to providing evidence for solar neutrinos, Super-Kamiokande has provided strong evidence that atmospheric neutrinos (neutrinos produced by cosmic ray interactions in the atmosphere) also oscillate. These seminal experiments rather than concluding the book on neutrinos have in fact just opened the door to the neutrino physics and emphasized how little we know and understand about neutrinos. The next generation of experiments, many of which require great depth and shielding, are designed to advance our understanding of neutrinos. These experiments include neutrinoless double-beta decay and next generation solar neutrino experiments as well as ancillary investigations of atmospheric neutrino oscillations in large multi-purpose detectors. These experiments are in various stages of development with some nearly ready to deploy as soon as the laboratory is available while others will require additional R&D and the development of affiliated accelerator-based beams of neutrinos.

An underground laboratory will permit the US to develop and rapidly advance a variety of topics that traditionally fall between the historically defined fields of nuclear and particle physics. These include nuclear astrophysics experiments, supernova detectors and nucleon decay experiments. These fields also had their birth in the United States, but in the past several decades have had to seek facilities and sites overseas. The Homestake facility will provide a synergistic environment to efficiently and effectively advance these topics that are among the most important questions facing the next generation of physicists. Nearly half of the key questions identified in the National Academy Study, *Connecting Quarks to the Cosmos: Eleven Science Questions for the New Century* either require a deep underground laboratory to adequately accomplish the experiments or would greatly benefit from a national facility. Such a facility could significantly reduce experimental costs by sharing infrastructure, technology, and experience.

A key partner in underground laboratory would be earth science and geology. The geophysics community would be involved almost immediately in designing, planning and realizing the laboratory. The Earth Science community has a clear vision for a national facility to pursue these topics. A national facility at Homestake would help this community realize this dream. It would for the first time place the traditional underground physics community shoulder-to-shoulder with their geophysics community.

We are working closely with the South Dakota Underground Authority, the National Science Foundation, and the US underground science community to develop responses to the three solicitations recently discussed by NSF. Berkeley will play a lead role in championing Homestake.